Heat Related Illnesses

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Objectives

- Discuss biophysics of heat production and cooling
- Discuss various forms of heat related illness and their management
- Discuss limiting heat stress in adverse military climates

You May Well Ask . . .

We'll try to employ the 3 "L"s

Laugh, Learn, Leave

Attempt to Maintain SA!!

Otherwise…

Biophysics of Heat Exchange

- Core Temperature =
  + Metabolic Heat
  +/- Conduction
  +/- Radiation
  +/- Convenction
  - Evaporation

Epidemiology

- Estimates up to 4000 deaths/year in USA
- Second leading cause of death in young athletes
- Military factors increasing risk of heat related injury:
  - Hot environment with little to no time for acclimitization
  - Bulky uniform, chem gear, cockpit, tank, Humvees, etc.
  - Prolonged exertion and lack of mobility

THE ARABIAN PENINSULA
300 Miles
300 km
IRAQ
IRAN
JOR.
Al Jawf
Tabūk
An Nafūd
Ad Dahnā'
Al Kuwait
KUWAIT
Persian Gulf
Str. of Hormuz
BAHRAIN
Manama
OMAN
Gulf of Oman
QATAR
Doha
Dubayy
Abu Dhabi
Muscat
U.A.E.
Ra's al Hadd
Jaʿirat Maşīrah
Al Wajh
Buraydah
Ad Dammām
Al Hufūf
EGYPT
Najd
Jabal al Ḥijāz
Yanbu' al Baḥr
Medina
Riyadh
SAUDI ARABIA
ARABIAN PENINSULA
Jiddah
Mecca
Aṭ Ṭā'if
Rub' al Khali
OMAN
Jabal Sawdā'
3,133 m
SUDAN
Abhā
Farasan Is.
ERITREA
Sanaa
YEMEN
Saywūn
Salālah
ARABIAN SEA
Al Ḥudaydah
Ta'izz
Sayḥūt
Al Mukallā
Hadīboh
Socotra (YEMEN)
ETHIOPIA
Aden
Gulf of Aden
Bab el Mandeb
DJIB.

Case #1:

- 19 year old male brought in from remote field site with altered mental status

P: 115 RR: 20 B/P: 118/66

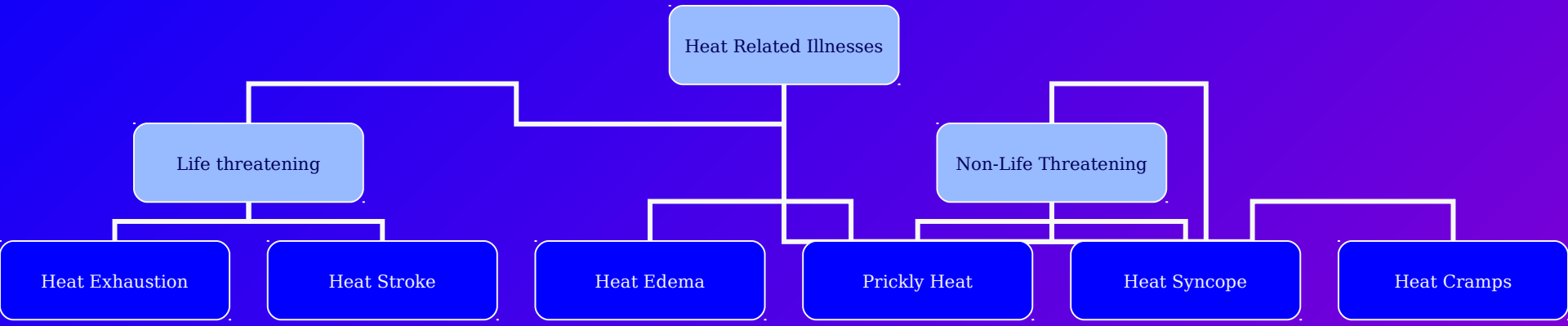
Pulse-Ox: 99% T: 100F

Sweating Wet (drenched en route)

Mucus membranes dry

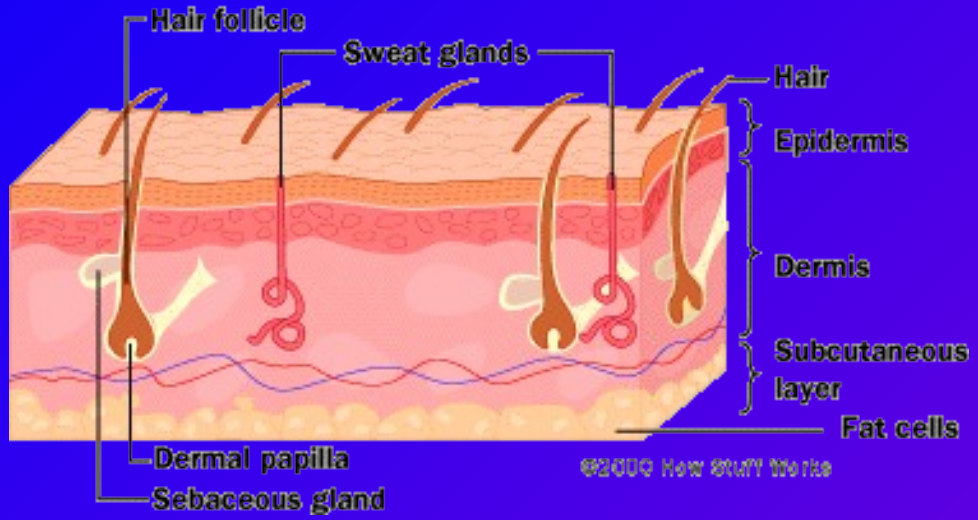
Minimally Responsive

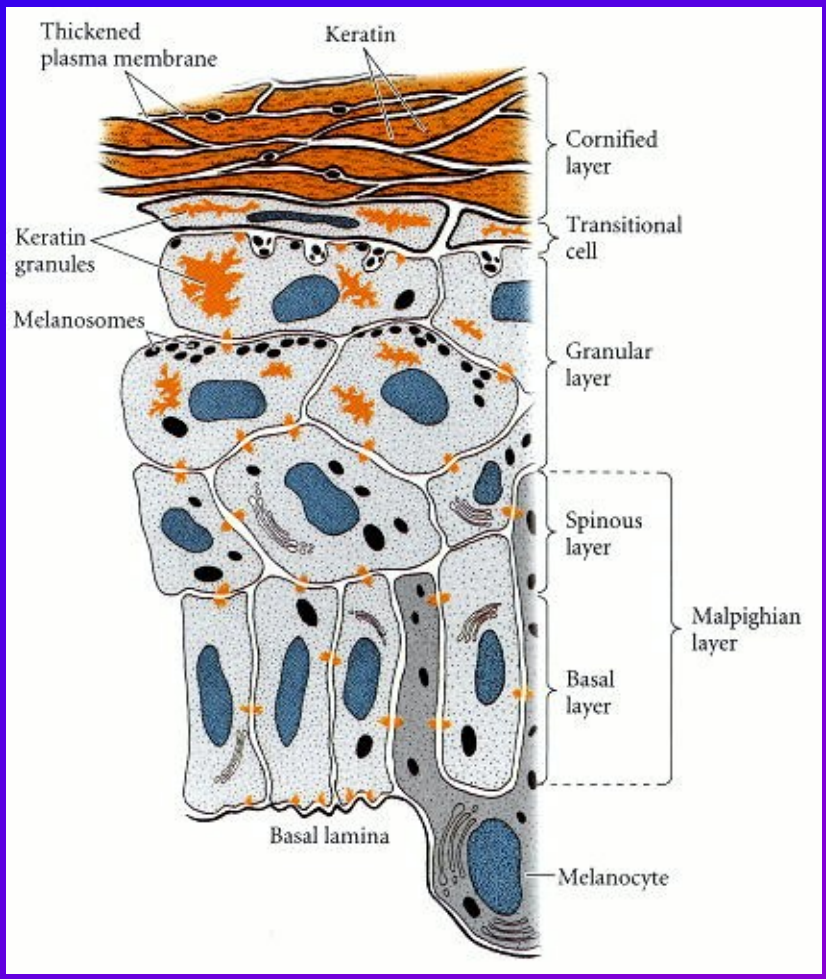
DDx:


Heat Related Illnesses
Life threatening
Non-Life Threatening
Heat Exhaustion
Heat Stroke
Heat Edema
Prickly Heat
Heat Syncope
Heat Cramps

Prickly Heat

- Pruritic, maculopapular Rash
- Clothed areas of the body
- Blocked sweat ducts by macerated stratum corneum
- Rupture to form vesicles in the malpighian layer


Hair follicle
Sweat glands
Hair
Epidermis
Dermis
Subcutaneous layer
Fat cells
Dermal papilla
Sebaceous gland
©2000 How Stuff Works


Thickened plasma membrane
Keratin
Cornified layer
Transitional cell
Keratin granules
Melanosomes
Granular layer
Spinous layer
Malpighian layer
Basal layer
Basal lamina
Melanocyte

Heat Edema

- Swelling and tightness of hands/feet
- Diuretics not effective and may cause iatrogenic complications:
  - Volume depletion
  - Electrolyte abnormalities
  - Impair thermoregulation, causing serious heat injury

Case #2

- 28 y.o. AD male passes out while performing DECON team training
- VS: P104 R22 B/P110/45, T100.1F
- Thoughts?

Heat Syncope

- Postural hypotension
- Due to:
  - Peripheral vasodilation
  - Decreased vasomotor tone
  - Relative volume depletion

Case #3

- 33 year old male running on the jogging track at 1300 hours develops severe pain and spasms in his legs
- VS: P98 R20 B/P 134/80
- Thoughts?

Heat Cramps

- Painful involuntary contractions (us. Calves)
- More common with intense sweating and hypotonic fluid replacement
- Pain often recalcitrant to opiods
- Rhabdomyolysis can occur infrequently

Case #4

- 25 year old male BMT jogging in formation complains of spasm and pain in her hands and feet
- VS: P88 R18 B/P118/74 T98.8F (orally)
- Pt appears extremely anxious, cannot catch her breath, feels as though she is going to pass out

Heat Tetany

- Misnomer of sorts!
- Hyperventilation induced by combination of exercise (esp in sedentary people), heat and stress
- Due to respiratory alkalosis

Case #5

- 54 year old TCN painting outdoors at noon develops dizziness, nausea and headache
- VS: P130 R28 B/P100/54 T: 100.4 orally
- Thoughts?

Heat Exhaustion

- A diagnosis of exclusion!
- Depletion of water and salt leads to:
  - Dizziness/lightheadedness
  - Malaise/fatigue
  - nausea/vomiting
  - Cephalgia
  - Myalgias
  - May have associated heat cramps

Heat Exhaustion

- Mental Status is ***NORMAL***
- Core Temperature:
  - Normal to 104F (not reliable criteria)
- Labs:
  - Hemoconcentration
  - Variable electrolyte abnormalities

Case #6
(Did not occur in the Desert)

- 26 year old male runs out of his apartment screaming that he is going to die. Police and EMS are called. Pt collapses in front of the EMS crew as the SAPD are trying to calm the man down
- Pt is intubated, CPR begun, given Epi Q5 min via IV, given 1L NS. Pt arrives in full arrest with ~15 minute transport time

Heat Stroke

- High Mortality
- Classical Definition:
  - T> 40.5F
  - CNS dysfunction
  - Anhidrosis

Heat Stroke

- CNS Dysfunction:
  - Irritability
  - Combativeness
  - Hallucinations
  - Seizures
  - Coma
- Pearl: Cerebellum is most temperature sensitive, therefore ataxia is often the earliest CNS finding

Heat Stroke

- Anhydrosis:
  - Many case reports of heat stroke victims sweating profusely
  - Anhydrosis appears to be a later finding with significant volume depletion and sweat gland dysfunction
  - May occur early with high temperatures, as the glands will not function at temperatures >107F

Heat Stroke DDX

- Alcohol withdrawl
- Amphetamines, PCP
- Anticholinergic toxicity
- Salicylate toxicity
- Malignant hyperthermia, NMS
- Typhoid fever
- Meningitis, encephalitis and sepsis
- Brain abscess
- Cerebral falciparum
- Status epilepticus
- Cerebral hemorrhage
- Thyroid storm
- DKA

Heat Exchange

- When air temperature is less than body temperature-primary mechanism of heat loss is radiation
- Convention increases with wind
- Evaporation is limited by relative humidity

Cooling Techniques

- Goal: Rapid drop to <40C (104F)
  - Antipyretics: Useless
  - Evaporative cooling (Makkah BCU)
  - Immersion
  - Gastric/bladder/peritoneal lavage
  - Cardiopulmonary bypass

Complications of Management

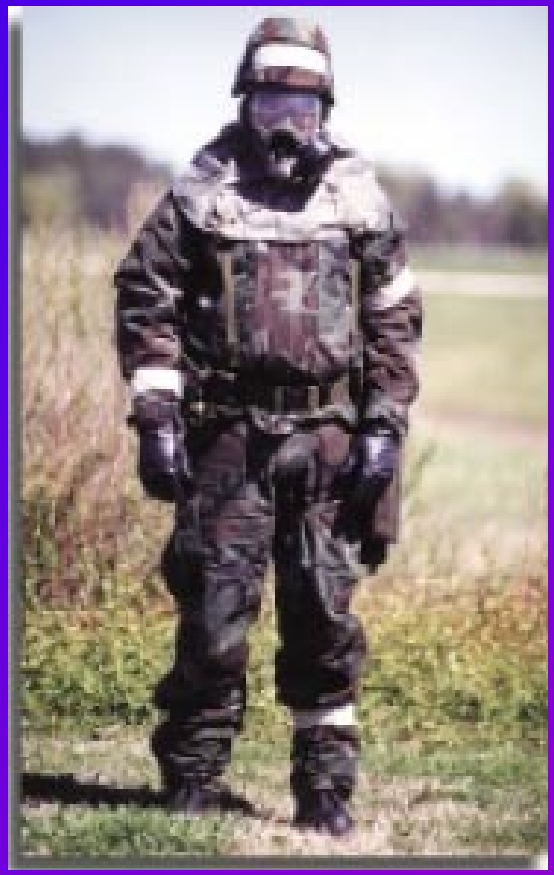
- Shivering
- CHF/Pulmonary Edema
- Cardiovascular collapse
- Hepatic centrilobular necrosis
- Renal: hematuria, proteinuria, casts, ATN
- Rhabdomyolysis
- Heme: ↓ platelets, thrombin, fibrinogen
  - DIC rarely
- Electrolyte and fluid abnormalities

Know what to EXPECT

Never Underestimate the Power of Stupid People In Large Groups

Military and Heat Stress

- Adverse Environments (Lousy Travel Agents)
- Poorly Designed Chem Suits for Hot Environments
- Vehicles poorly designed for heat
- Prolonged work hours
- High Stress
- Risk of Dehydration



Example: DECON Team

"...The 19 member WMDT is designed to operate one 12 hour shift; if 24 hour operations are required, then a second UTC FFGLB 19 member WMDT should be deployed to man the second 12 hour shift."

"One 19 member WMDT can simultaneously process between 4-5 litter and 6-7 ambulatory patients in an hour, depending on the level and type of contaminant. This rate will decrease as heat stress and fatigue increase."

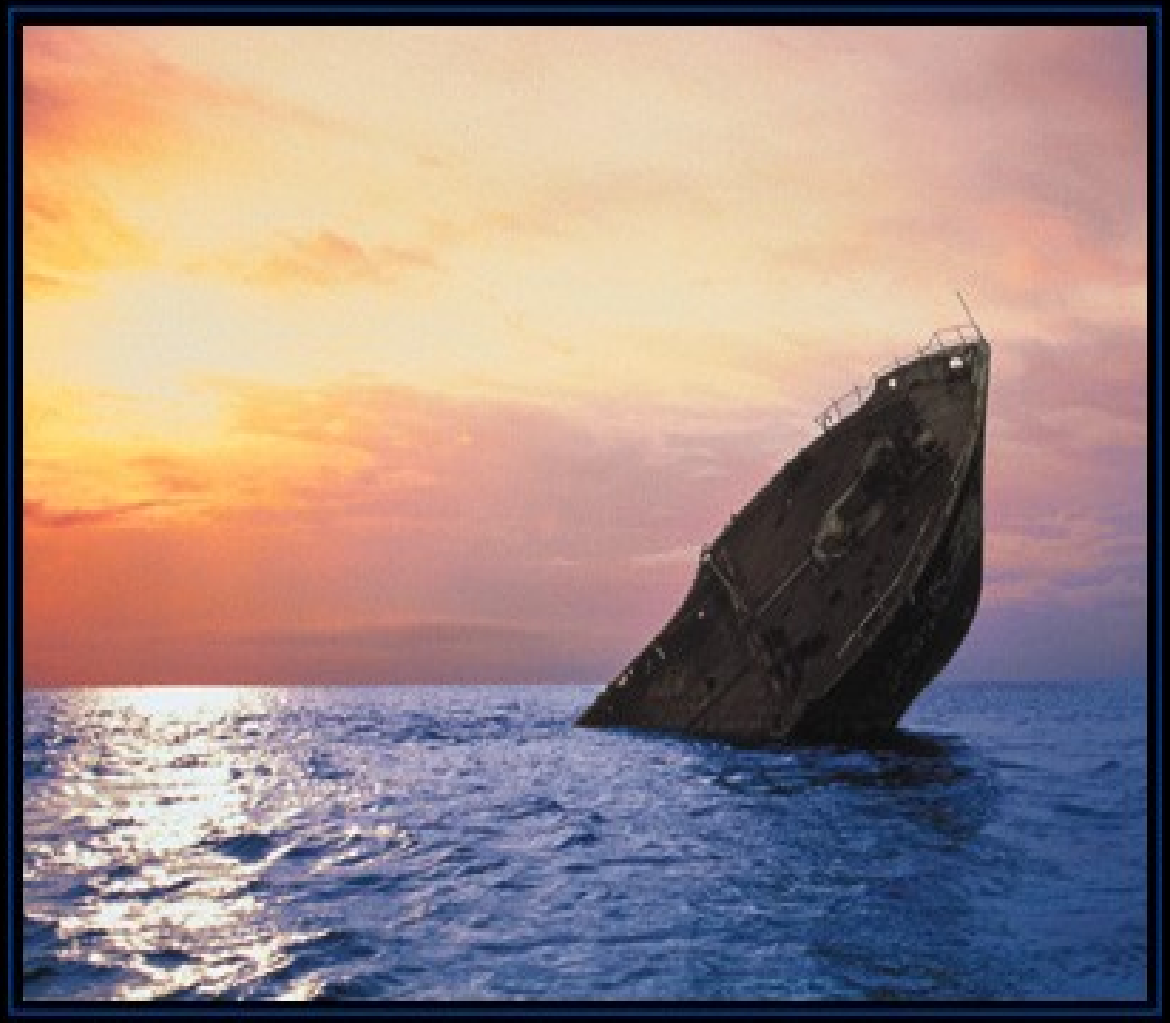
For The Wartime Medical Decontamination Team (WMDT)

Water Requirements

- **Daylight Operations**
  - **Personnel can sweat more than 1.5 quarts of water/hour during work periods**
  - **Drink 2 quarts of water/hour**
- **Be Aware**
  - **2°F body temperature increase affects mental performance**
  - **Thirst stimulus = 1-2% dehydra**
    - **3% = 20% decreased aerobic performance**
    - **3% = 35% decreased anaerobic performance**
  - **The difficulty of drinking in MOPP4 increases the likelihood of dehydration**

Task Performance Problems

- Reduces mobility, agility, coordination, dexterity
- Requires about 1.5 times longer to perform most physical tasks
- About 2.5 times longer for decision-making and precision control tasks



It Could be that the Purpose of Your Life is Only to Serve as a Warning to Others

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FUTILITY

You'll always Miss 100% of the Shots You Don't Take. And, Statistic ally Speakin

PSAB Chow Hall

Questions?

INEPTITUDE

If you Can't Learn to Do Something Well,

Learn to Enjoy Doing it Poorly